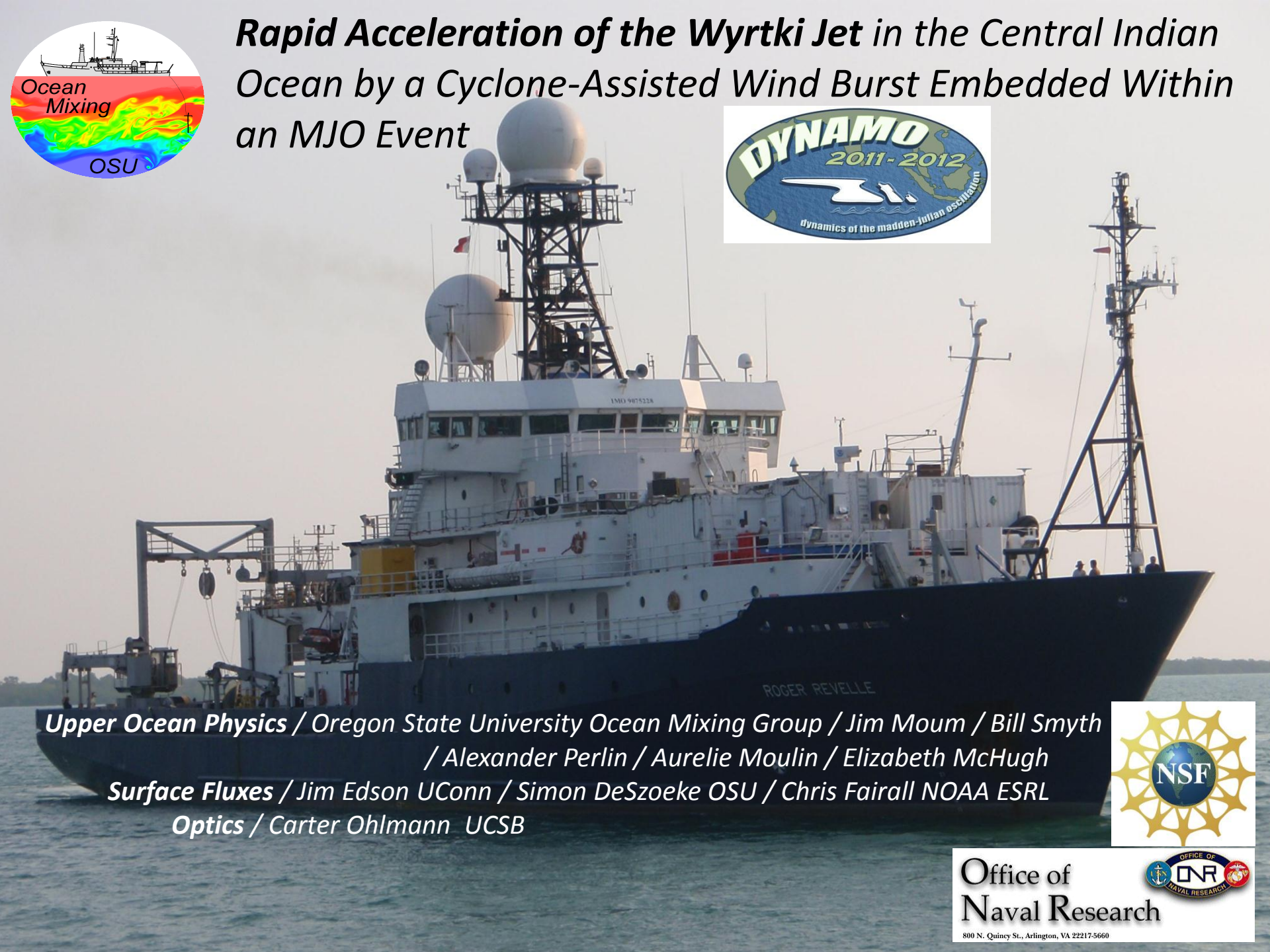
Rapid Acceleration of the Wyrtki Jet *in the Central Indian Ocean by a Cyclone-Assisted Wind Burst Embedded Within an MJO Event*



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Surface Fluxes */ Jim Edson UConn / Simon DeSzoeke OSU / Chris Fairall NOAA ESRL*

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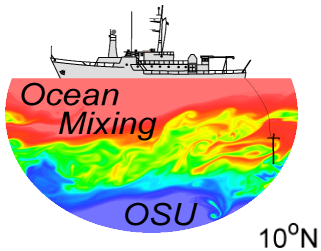
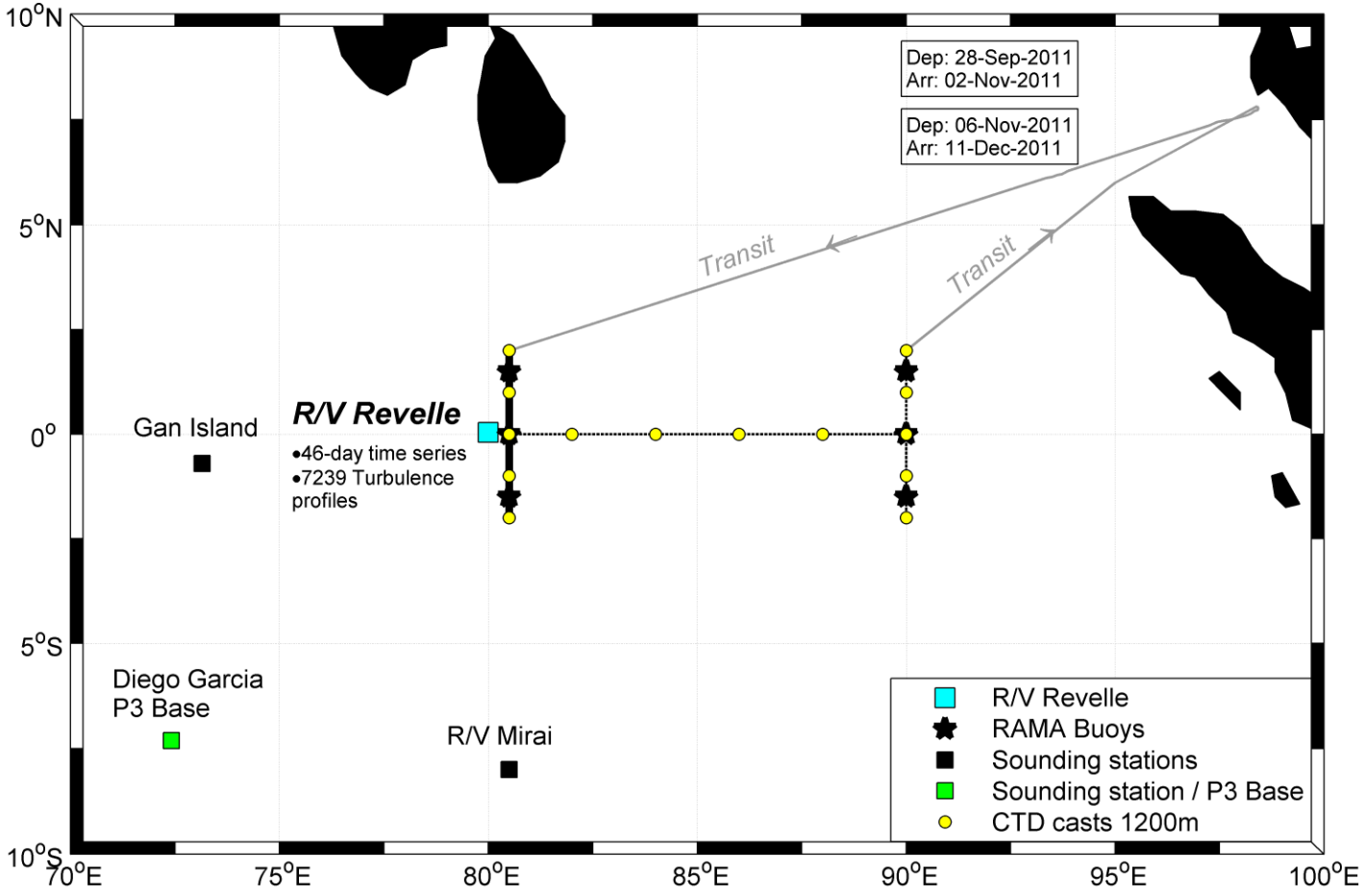
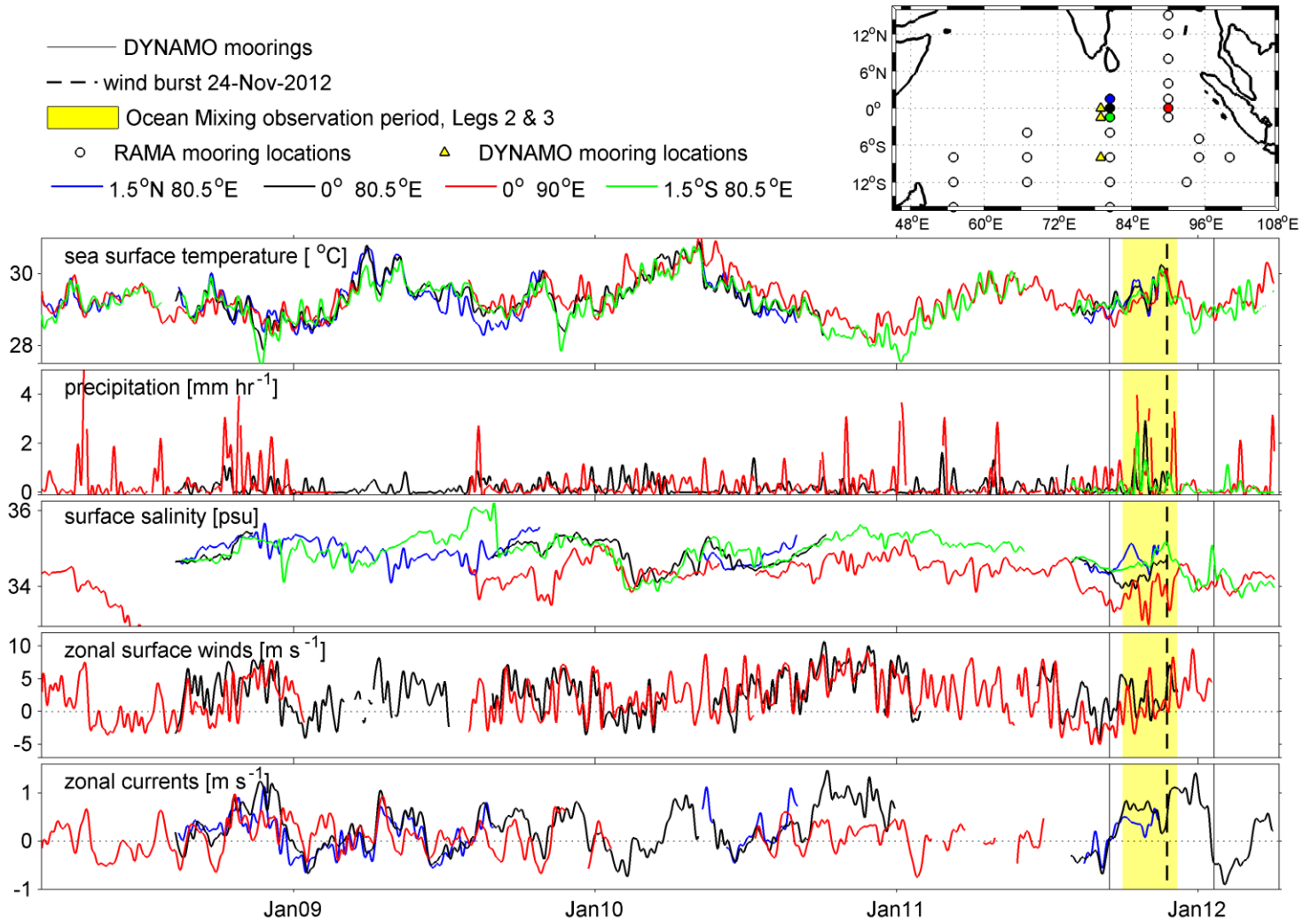
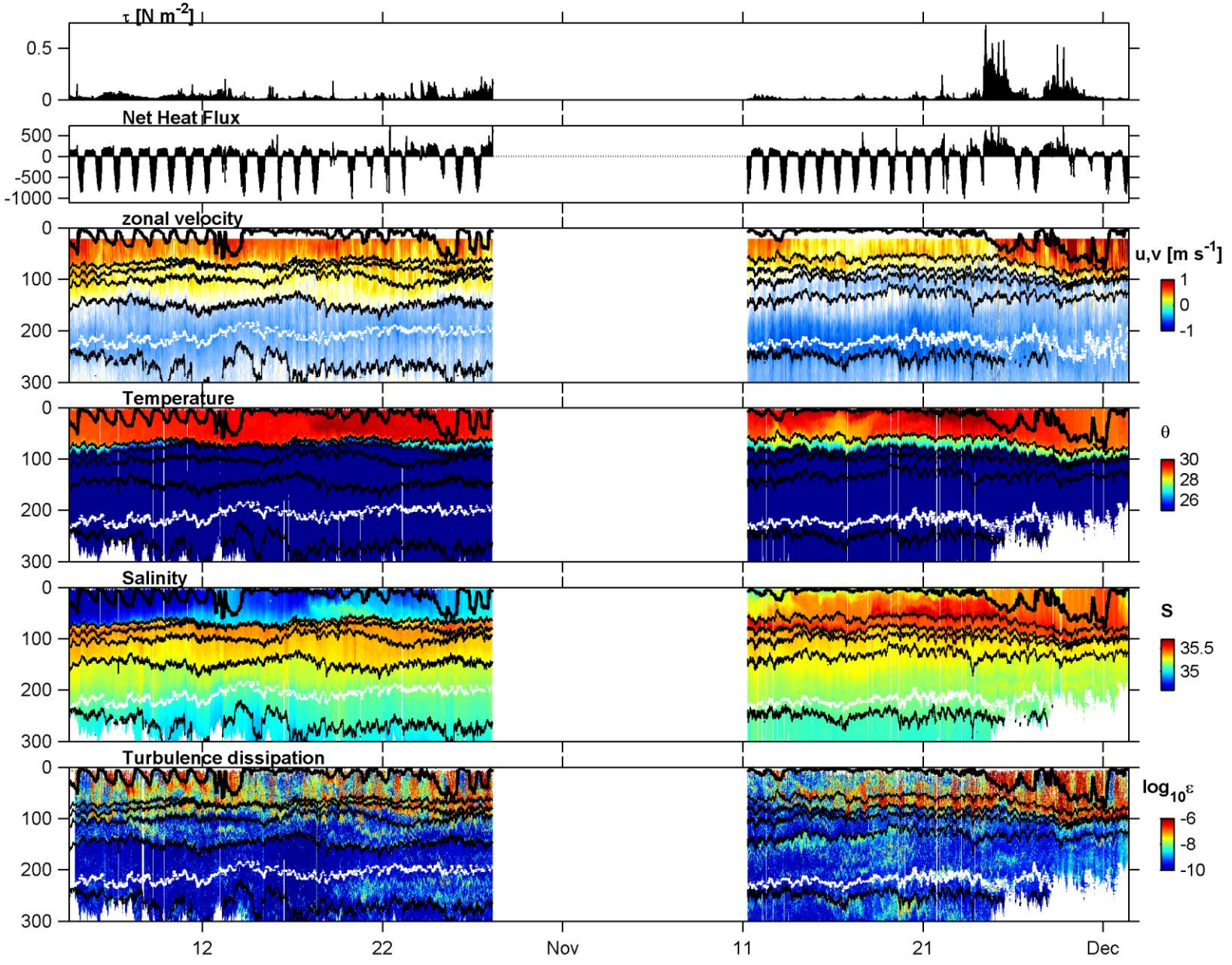




Aurelie Moulin

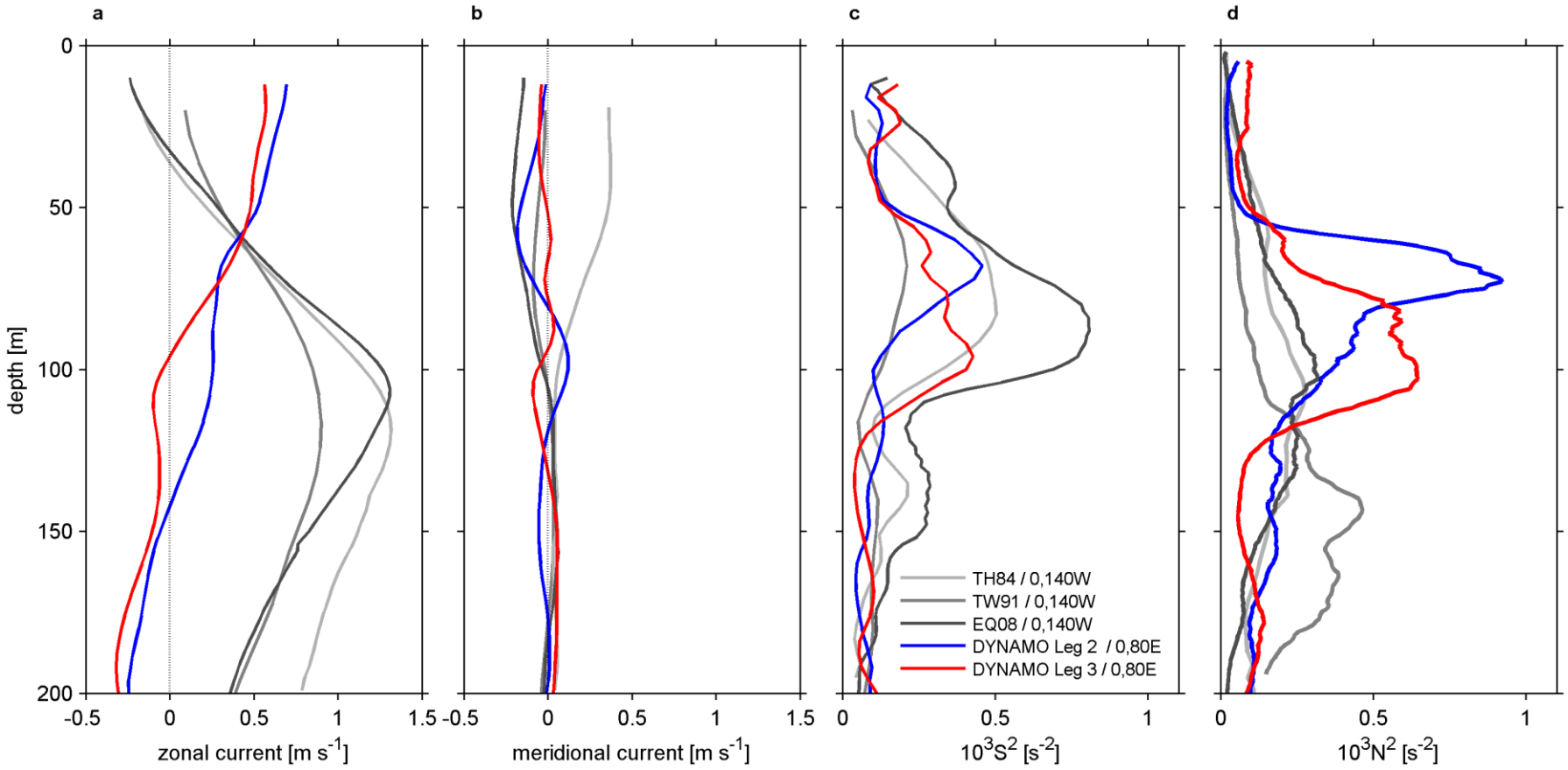


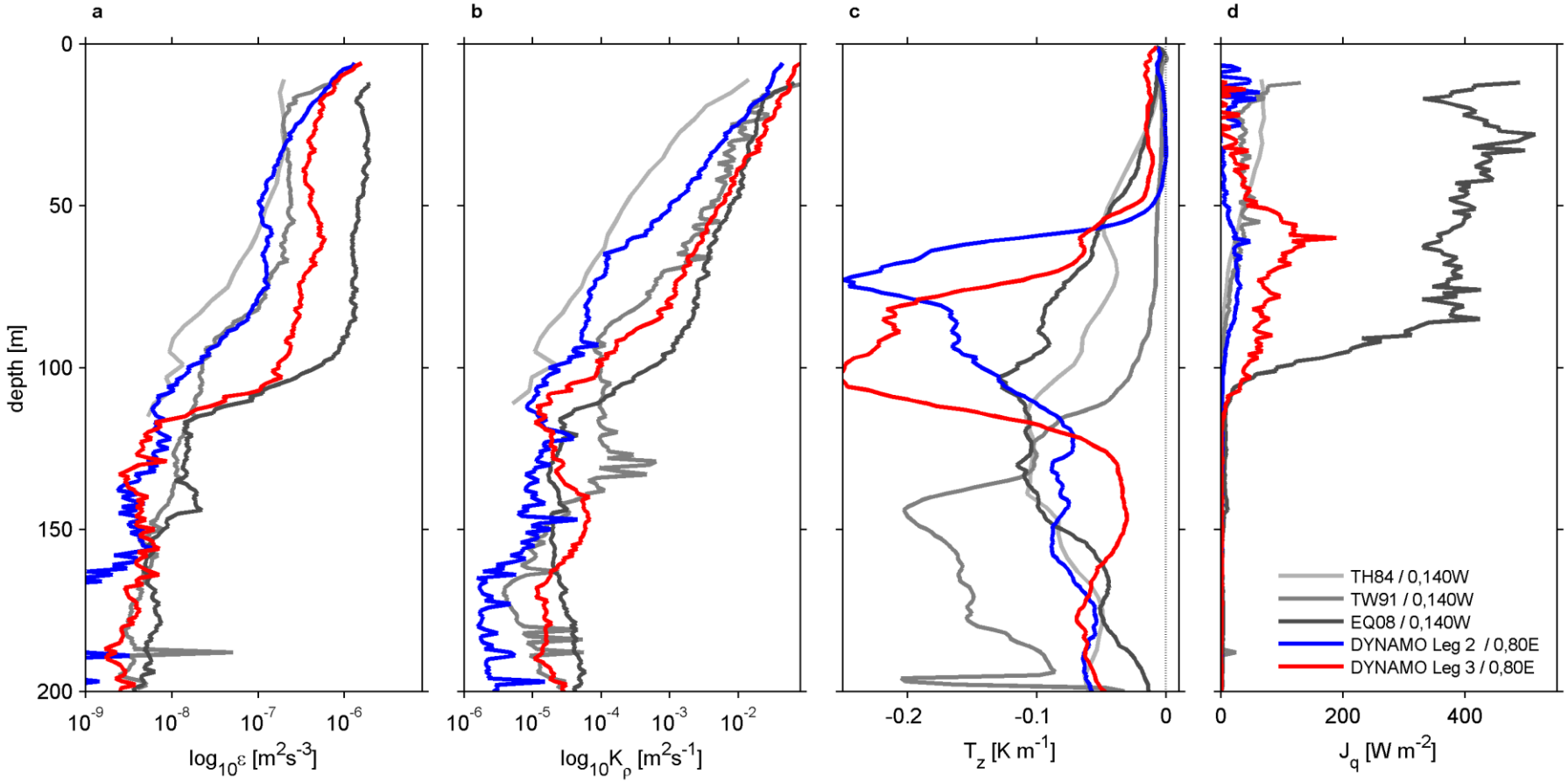
Elizabeth McHugh


τ [N m-2]
0.5
0
Net Heat Flux
500
0
-500
-1000
zonal velocity
0
100
200
300
u,v [m s-1]
1
0
-1
Temperature
θ
30
28
26
Salinity
S
35.5
35
Turbulence dissipation
log10ε
-6
-8
-10
12
22
Nov
11
21
Dec

central Pacific wind stress

Indian Ocean wind stress

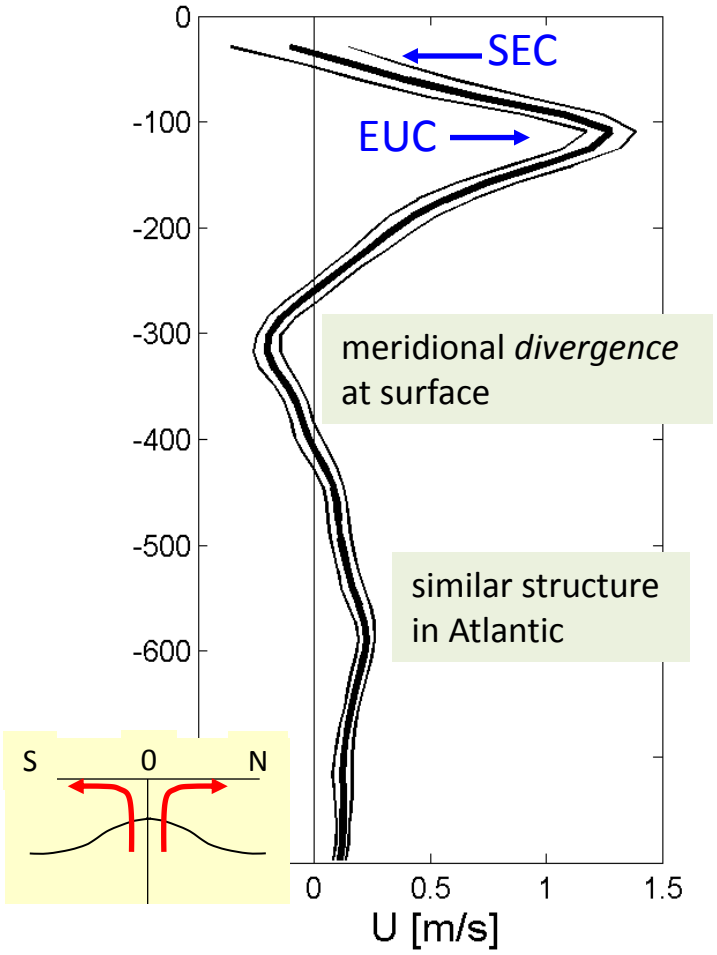



a
b
c
d
depth [m]
0
50
100
150
200
10^{-9}
10^{-8}
10^{-7}
10^{-6}
$\log_{10}\varepsilon$ [m^2s^{-3}]
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
$\log_{10}K_\rho$ [m^2s^{-1}]
-0.2
-0.1
0
T_z [K m^{-1}]
0
200
400
J_q [W m^{-2}]
TH84 / 0,140W
TW91 / 0,140W
EQ08 / 0,140W
DYNAMO Leg 2 / 0,80E
DYNAMO Leg 3 / 0,80E

Zonal currents at the Equator

0, 140W (**central *Pacific* Ocean**)

Trade Winds

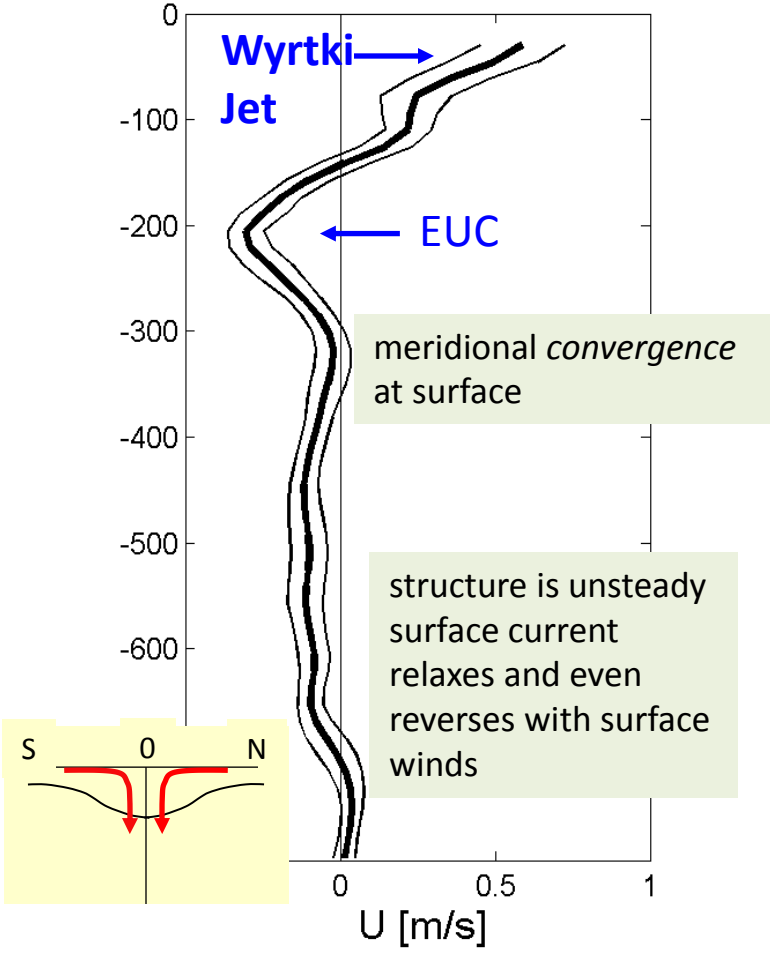


meridional *divergence* at surface

similar structure in Atlantic

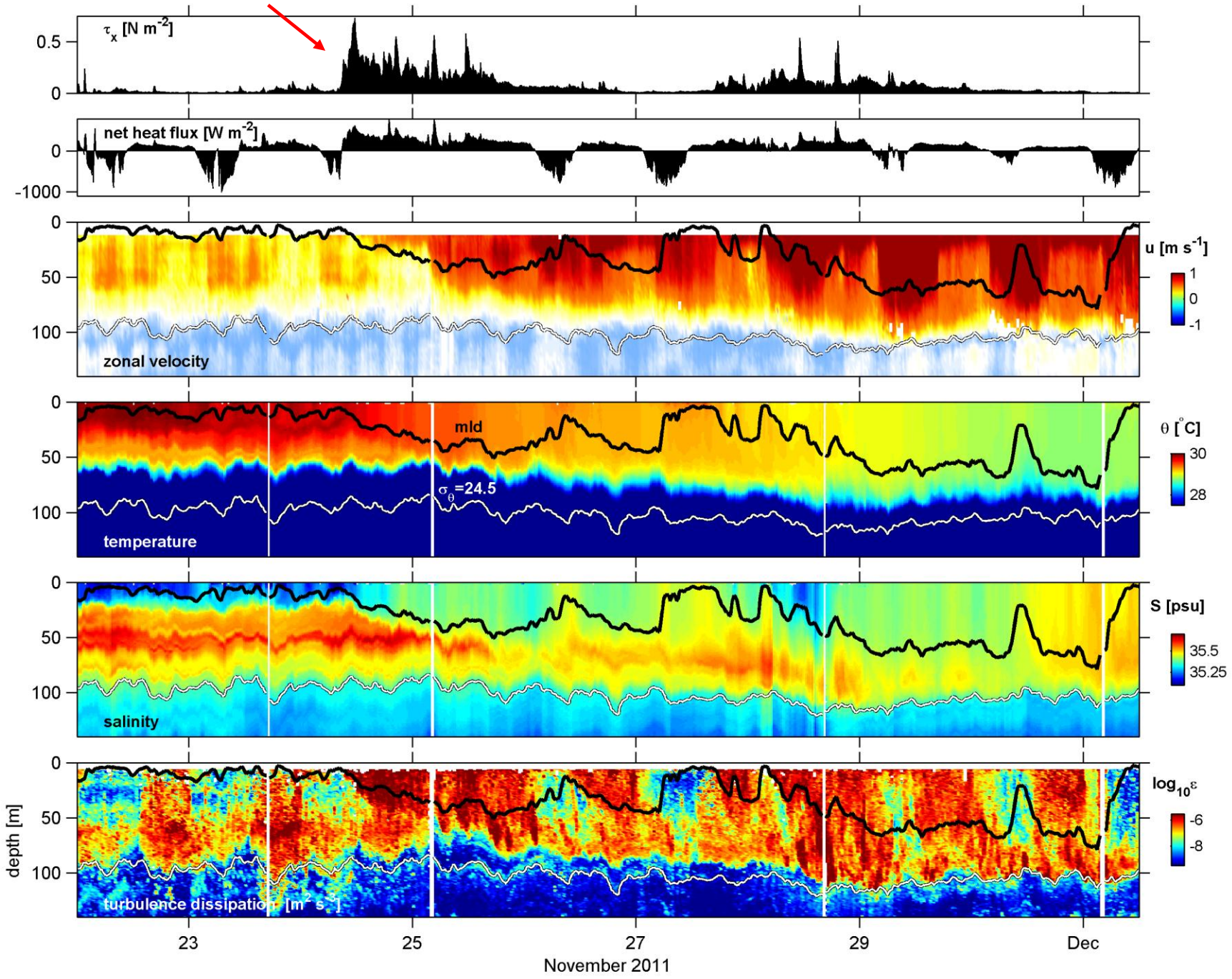
0, 80E (**central *Indian* Ocean**)

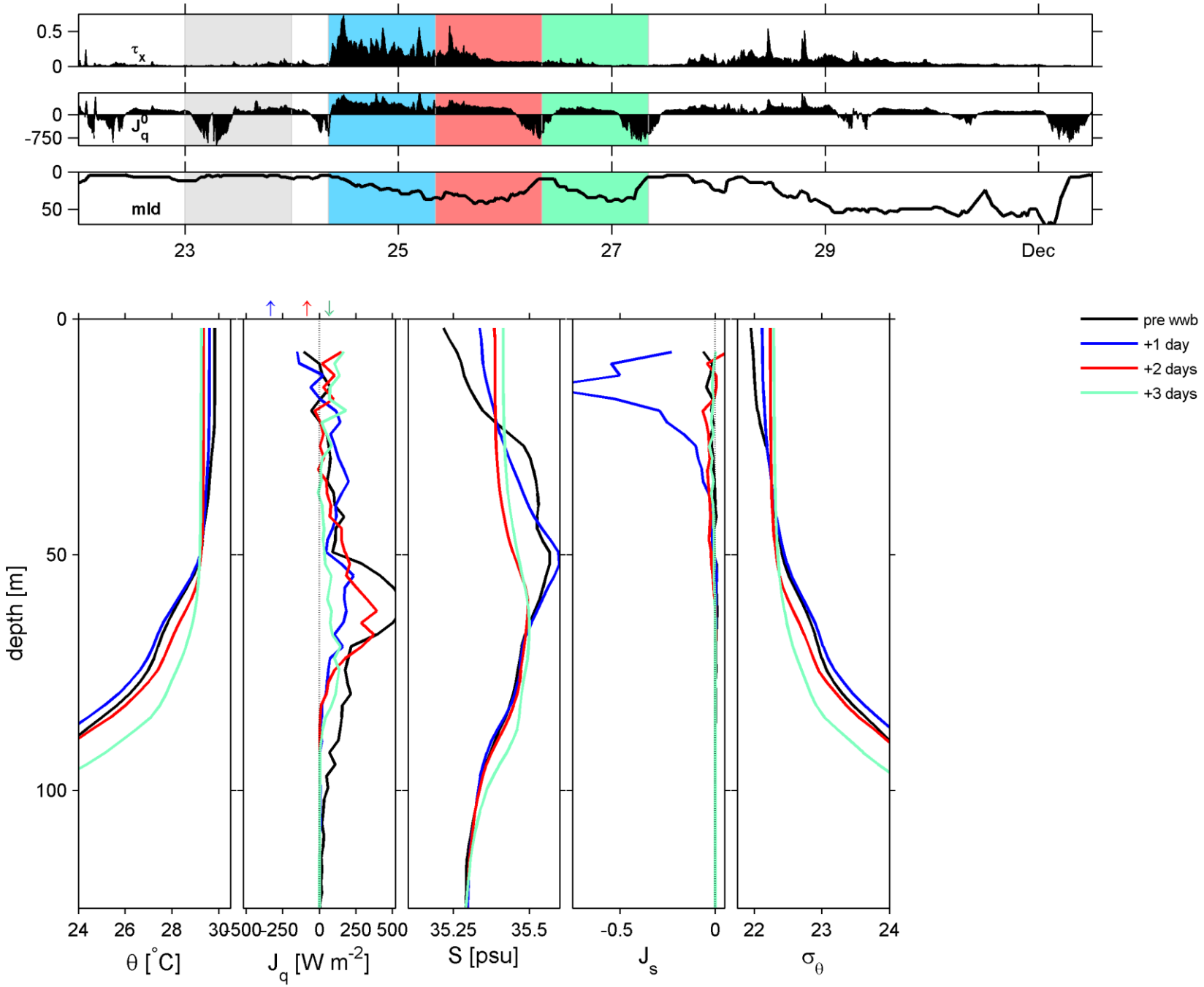
Westerlies



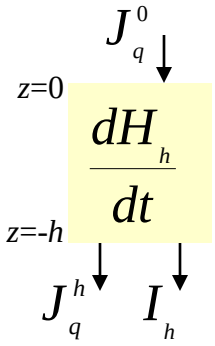
meridional *convergence* at surface

structure is unsteady surface current relaxes and even reverses with surface winds


arrival of leading front of cyclone-assisted MJO
τ_x [N m^{-2}]
0.5
0
net heat flux [W m^{-2}]
0
-1000
0
50
100
zonal velocity
u [m s^{-1}]
1
0
-1
mld
σ_θ=24.5
temperature
θ [°C]
30
28
salinity
S [psu]
35.5
35.25
depth [m]
turbulence dissipation [m^2 s^{-3}]
log$_{10}$ε
-6
-8
23
25
27
29
Dec
November 2011


0.5
0
τ_x
0
-750
J_q^0
0
50
mld
23
25
27
29
Dec
pre wwb
+1 day
+2 days
+3 days
depth [m]
0
50
100
24
26
28
30
θ [˚C]
-500
-250
0
250
500
J_q [W m^{-2}]
35.25
35.5
S [psu]
-0.5
0
J_s
22
23
24
σ_θ

1D mixed layer heat budget

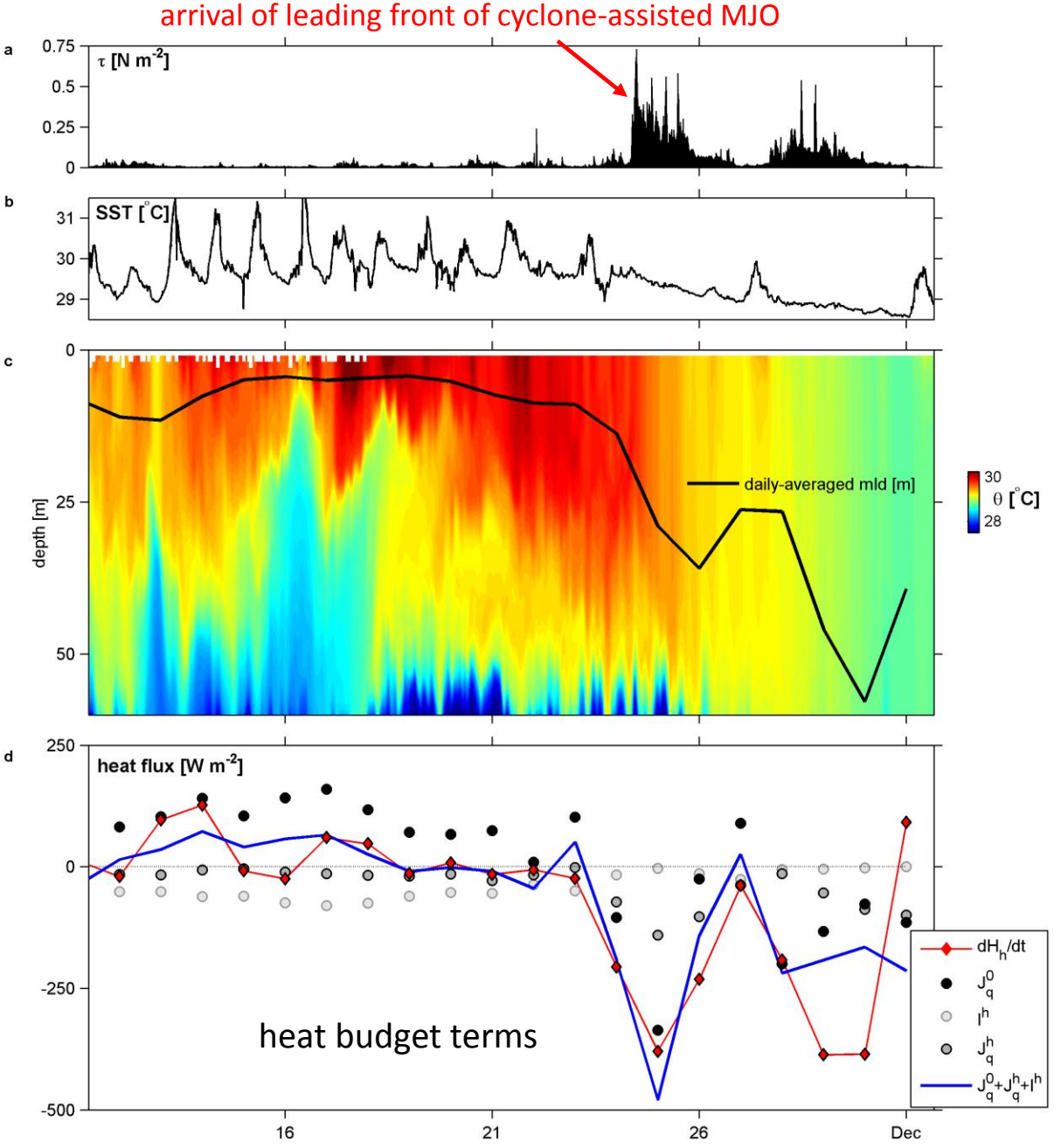


$$\frac{dH_h}{dt} = J_q^0 - I_h - J_q^h$$

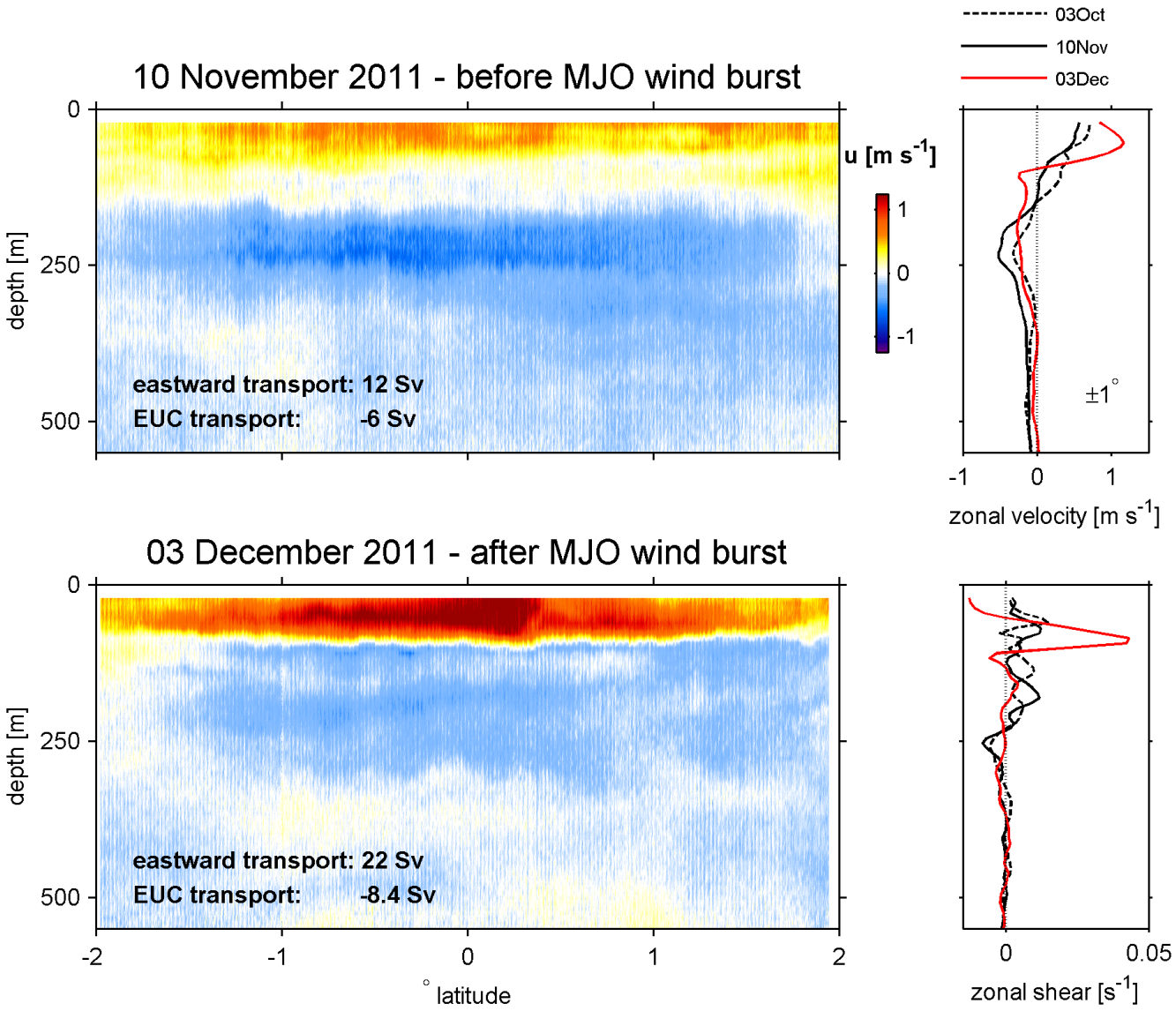
mixed layer heating rate =
surface heat flux –
penetrating radiation -
turbulent heat flux through
mixed layer base

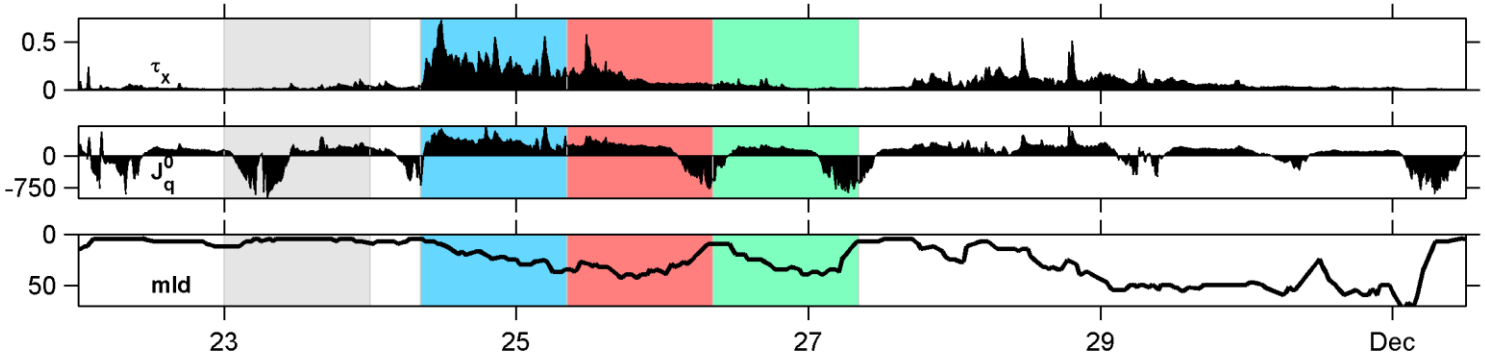
all terms measured
1D balance exists when
red diamonds = blue line

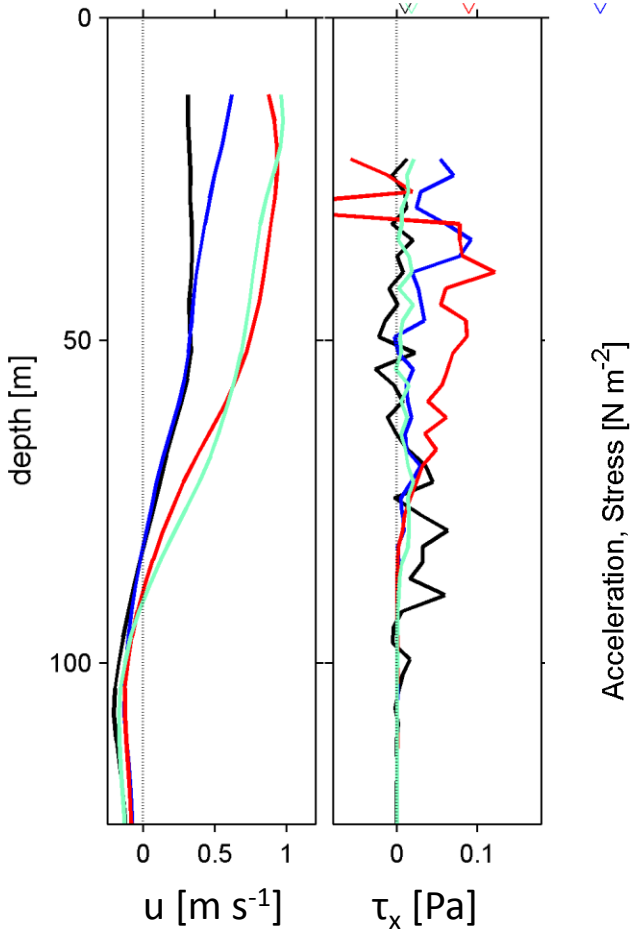
Relative roles of individual terms change with mixed layer depth and intensity of surface forcing



Cross-equatorial structure of the *Wyrtki Jet* before and after passage of the cyclone-assisted MJO wind burst

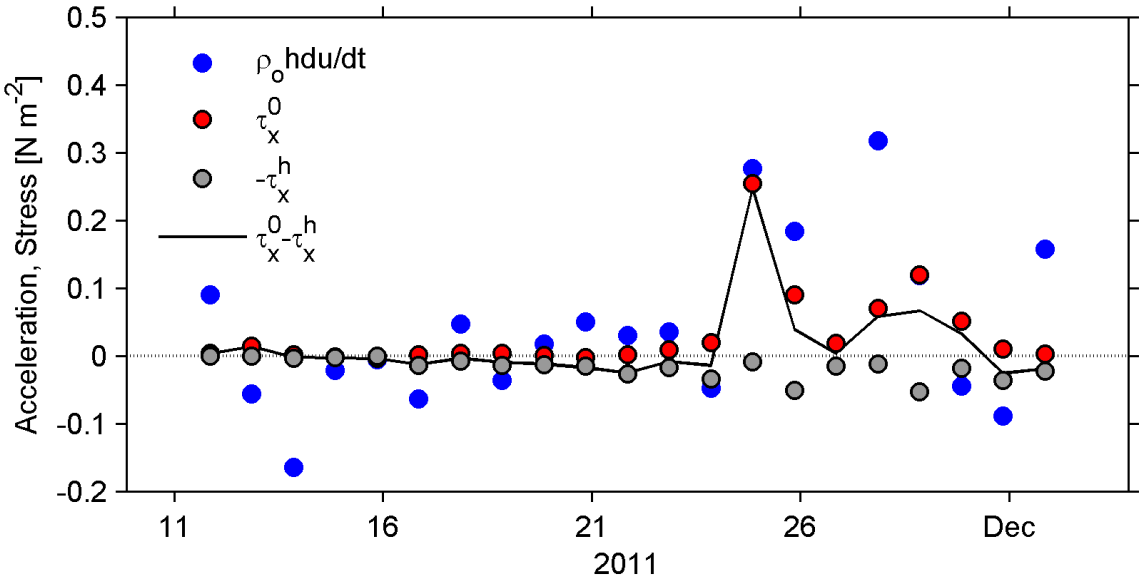


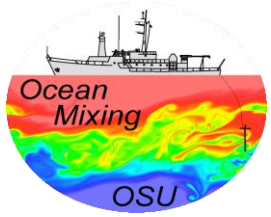




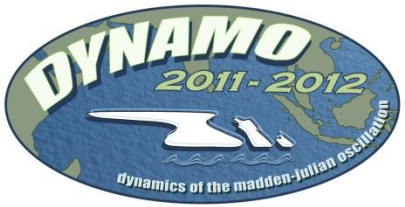
1st order *u*-momentum:

$$\int_0^h \rho \frac{\partial u}{\partial t} dz = \tau_x^0 - \tau_x^h$$





Summary



- measurements at 0, 80.5E in October/November 2011 include passage of a major MJO event

- although accompanied by considerable precipitation, the ocean surface quickly became saltier as subsurface entrainment mixing up salty water from below

- during the event, mixed layer cooling is completely balanced one-dimensionally
  - cooling rate of 0.4 k/day is due to -320 W m^{-2} from above to the atmosphere and -180 W m^{-2} from below due to subsurface mixing

- to first order, the acceleration of the Wyrtki Jet from 12 Sv (+/- 1 degree from the equator) to 24 Sv, quadrupling system kinetic energy, is balanced simply by the wind stress at the sea surface.